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Abstract

Some Critical Problems in Recent Swedish Work on Cladding Materials

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Swedish research work on cladding materials has in recent years essentially been concerned with zirconium alloys and stainless steel for water cooled fuel elements. The major part on zirconium has been done for the Ågesta reactor where the operating temperature is about 250° C (pressurized water). The aim of the studies of stainless steel is to find a canning material for the Marviken superheater elements which are to produce 500 °C steam.

Concerning zirconium alloys it has been found that Zircaloy-2 in the unirradiated condition might behave in a brittle manner if strained slowly. This embrittlement, which is associated with other irregularities in deformation behaviour due to metallurgical changes, is probably caused by deformation-induced hydride precipitation. Studies of texture have resulted in a suggestion that this property should not only be carefully observed but also intentionally employed for obtaining optimum strength and ductility of tubular components. After irradiation of Zircaloy-2 with varying hydrogen contents a yield point has been found. Comparative studies of dislocation structures in zirconium after different treatments have been made.

The effort done on corrosion of Zircaloy-2 has been limited to some exploratory studies of the electrochemistry of water corrosion and a series of hydrogen absorption measurements, in and out-of-pile, on Ågesta canning material of various sources and treatments. Parallel to this work studies on the metallography of Zircaloy have been made, providing information on the composition of the second phase in Zircaloy-2 and the microstructural appearance of the hydride as well as its solubility.

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For superheat element canning a number of alloys of stainless steel type, mainly austenitic alloys with increased nickel content, are being extensively studied. Besides the properties generally considered, i.e. corrosion resistance and mechanical strength and ductility, a few critical properties are examined with particular care. These are, on the corrosion side, pitting and chloride-induced stress corrosion, both transgranular and intergranular, the latter in high temperature steam. On the mechanical side particular attention is given to strain fatigue and other processes leading to reduced ductility.

The microstructural background to these phenomena is followed and a few observations on segregation of minute amounts of boron, believed to be related to embrittlement by thermal neutrons, have been made.